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Glenn Springs Holdings, Inc.
A subsidiary of Occidental Petroleum Corporation

REMEDIAL ACTION OBJECTIVES & PRELIMINARY REMEDIAL GOALS TECHNICAL MEMORANDUM FEASIBILITY STUDY

Newark Bay Study Area

Newark Bay, New Jersey

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CONTENTS

TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-*p*-dioxin
AOC	Administrative Order on Consent
ARARs	applicable or relevant and appropriate requirements
Bay	Newark Bay
BERA	baseline ecological risk assessment
BHHRA	baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COCs	constituents of concern
CTE	central tendency exposure
DDx	dichlorodiphenyldichloroethane, dichlorodiphenyldichloroethylene, and dichlorodiphenyltrichloroethane
FFS	focused feasibility study
FS	feasibility study
FS WP	feasibility study work plan
GSH	Glenn Springs Holdings, Inc.
HI	hazard index
ICT	Identification of Candidate Technologies
LPR	Lower Passaic River
LPRSA	Lower Passaic River Study Area
mg/kg	milligrams per kilogram
NBSA	Newark Bay Study Area
NCP	National Contingency Plan
NJ	New Jersey
NJDEP	New Jersey Department of Environmental Protection
OU	operable unit
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PRGs	preliminary remedial goals
RAOs	remedial action objectives
RAS	Remedial Alternatives Screening

RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
SQT	sediment quality triad
SumTU	sum of toxic units
TBCs	to be considered
TRVs	toxicity reference values
USEPA	U.S. Environmental Protection Agency
WQC	water quality criteria
µg/kg	micrograms per kilogram

1 INTRODUCTION

The Diamond Alkali Superfund Site was added to the Superfund National Priorities List on September 21, 1984 because of contaminants present at the site. Four different operable units (OUs) are associated with the site (Figure 1-1): the former manufacturing plant and surrounding properties at 80 and 120 Lister Avenue (OU1), the lower 8.3 miles of the Passaic River (OU2), the Newark Bay Study Area (NBSA; OU3), and the lower 17 miles of the Passaic River (OU4; Lower Passaic River Study Area [LPRSA]; U.S. Environmental Protection Agency [USEPA] 2016). The NBSA has been defined as Newark Bay (Bay) and portions of key tributaries, including the Hackensack River, Arthur Kill, and Kill van Kull. Additional details on the site setting and NBSA characteristics are included in the Draft Remedial Investigation Report (Glenn Springs Holdings, Inc. [GSH] In Progress).

Pursuant to the Administrative Order on Consent (AOC) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; Index 02-2004-2010; USEPA 2004), GSH, on behalf of Occidental Chemical Corporation (the successor to Diamond Shamrock Chemicals Company [formerly known as Diamond Alkali Company]), is conducting a remedial investigation/feasibility study (RI/FS) for the NBSA. The Statement of Work includes preparation of a baseline human health risk assessment (BHHRA), baseline ecological risk assessment (BERA), and feasibility study (FS) report. The purpose of the RI/FS process is to characterize the nature and extent of chemical contamination, develop and evaluate appropriate remedial options, and gather necessary information to select an appropriate remedy for the site.

As part of the RI/FS process, the Feasibility Study Work Plan for the Newark Bay Study Area (FS WP; GSH 2017) was prepared to define the technical approach and seven associated technical tasks for completing the FS Report. This Remedial Action Objectives and Preliminary Remedial Goals Technical Memorandum (RAO/PRG Tech Memo) documents the results of the first task in the FS WP – Task 1: Description of Remedial Action Objectives and Preliminary Risk-Based Remediation Goals. This RAO/PRG Tech Memo has been prepared to:

- Identify and conduct an analysis of the applicable or relevant and appropriate requirements (ARARs) – see Section 2.
- Describe the remedial action objectives (RAOs) and relationship to preliminary remedial goals (PRGs) – see Section 3.
- Identify the next steps in the FS process – see Section 4.

This RAO/PRG Tech Memo has been developed in consideration of the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA 1988). This document considers the results of the RI, BHHRA, and BERA reports underway or completed for the NBSA. Each section will describe how the ARARs, RAOs, and PRGs will focus and form the framework for the FS Report consistent with the CERCLA guidance.

2 ARARS

CERCLA specifies that “Superfund remedial actions must meet any Federal standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate requirements (ARARs)” (Section 121(d)(2)(A)). This also includes relevant state and/or local ARARs if they are more stringent than federal requirements. Waivers for ARARs may be justified based on specific circumstance. This section defines the ARAR categories, grounds for waivers, and provides potential ARARs for each category.

2.1 Identification of ARARs

The three broad categories of ARARs include chemical-specific, location-specific, and action-specific. Each of these categories are defined in the bullets below.

- Chemical-specific ARARs are numerical standards that specify the acceptable amount or concentration of a chemical that may be found in or discharged to the ambient environment. These are specific to the type(s) of constituents, pollutants, or hazardous substances at a site, and include state and federal regulations pertaining to contaminant levels in various media.
- Location-specific ARARs are restrictions placed on the concentrations of hazardous substances or the conduct of activities, solely based on their geographic locations. They establish requirements that protect areas of special interest such as floodplains, wetlands, historic places, or sensitive ecosystems or habitats.
- Action-specific ARARs are technology- or activity-based requirements on potential remedial actions taken within the NBSA. Action-specific ARARs are regulatory requirements that define acceptable remedial technologies and are triggered by the remedial activities selected to accomplish a remedy.

In accordance with Section 121(d)(4) in CERCLA, there are six circumstances under which ARARs may be waived.

- The remedial action selected is only a part of a total remedial action (interim remedy) and the final remedy will attain the ARAR upon its completion.
- Compliance with an ARAR will result in a greater risk to human health and the environment than alternative options.
- Compliance with the ARAR is technically impracticable from an engineering perspective.
- An alternative remedial action will attain an equivalent standard of performance using another method or approach.
- The ARAR is a state requirement that the state has not consistently applied (or demonstrated the intent to apply consistently) in similar circumstances.
- For §104 Superfund-financed remedial actions, compliance with the ARAR will not provide a balance between protecting human health and the environment and the availability of Superfund money for response at other facilities.

If an ARAR waiver is determined to be appropriate, the reasons for the determination will be presented in FS Report for the alternative.

In addition to ARARs, to be considered (TBCs) must also be identified as appropriate. These are non-promulgated advisories, criteria, or guidance developed by the USEPA, other federal agencies, states, or localities that may be useful in developing CERCLA remedies. TBCs are not legally binding and do not have the status of ARARs. NBSA alternatives will be screened against both identified ARARs and TBCs (where applicable) in the FS Report.

2.2 Summary of ARARs for the NBSA

Identification of ARARs and TBCs specific to the NBSA considers those identified in the Focused Feasibility Study Report for OU2 in the Lower Passaic River (LPR) (LPR FFS; USEPA 2014) due to the contiguous relationship between the two waterbodies and various OUs of the site. These include federal and New Jersey (NJ) State ARARs/TBCs. Modifications were then made considering characteristics and applicability of laws/regulations unique to the NBSA. In addition, New York (NY) State ARARs were also identified, as the southern shoreline of Newark Bay and the Kill van Kull, and the eastern shoreline of the Arthur Kill, border Staten Island, NY.

Chemical-specific ARARs and TBCs were evaluated for surface water and sediment. Any ARARs or TBCs tied to remedial construction (e.g., air emissions, disposal requirements, etc.) are included as action-specific ARARs. Based on the risk assessment work, there are no risks associated with current surface water conditions in the NBSA. In addition, in consideration that the NBSA is OU3 of the overall Diamond Alkali Superfund Site, compliance with surface water ARARs depends on the overall remedy for OU2 and OU4 (Lower 8.3 miles of the LPR and 17-mile LPRSA, respectively). As such, the NBSA (OU3) FS does not provide surface water-specific ARARs or TBCs. There are no chemical-specific ARARs identified for the NBSA sediments. As further described in Section 3, site-specific sediment PRGs have been defined based on risk assessment results and these values will drive any potential remedial actions for the NBSA.

The location-specific ARARs and action-specific ARARs and TBCs for the NBSA have been identified on Tables 2-1 and 2-2, respectively. Compliance with ARARs is one of the nine criteria considered under CERCLA in the evaluation of potential remedial alternatives in the FS Report. ARARs, along with RAOs, will support development of the remedial alternatives and implementation of the selected remedy. Note also that in accordance with CERCLA Section 121(e), permits required as part of the various ARARs are not required for onsite CERCLA response actions; however, the selected remedy must comply with the substantive requirements of regulations that otherwise would require permits.

3 RAOS AND PRGS

Developing RAOs and PRGs is the first step in identifying and screening remedial alternatives to address the constituents of concern (COCs) and target media. This section presents the proposed RAOs and describes the PRGs developed to achieve each of the RAOs.

3.1 Introduction

RAOs consist of site-specific and medium-specific goals for protecting human health and the environment. These objectives are based on potential human health and ecological risks and are identified to protect those receptors and associated exposure pathways where the risk assessments concluded risk was present or likely. Therefore, NBSA-specific RAOs were developed using the findings from the BHHRA and BERA, considering available information and standards (such as ARARs and/or TBCs), and in consultation with the USEPA. A summary of the baseline risk assessment information in provided in Section 3.2, and a list of the RAOs is presented in Section 3.3.

PRGs are chemical-specific cleanup goals established to protect human health and the environment. These goals comply with ARARs and serve as long-term targets to use during the analysis and selection of remedial alternatives. The basis for developing PRGs is provided in Section 3.4.

3.2 Summary of Risk Assessments

Baseline human health and ecological risk assessments were conducted in the NBSA and resulted in the following key findings:

- Consumption of self-caught fish and crab by anglers is the only identified exposure pathway resulting in human health risk. The primary drivers of human health risk are 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD) and polychlorinated biphenyls (PCBs).
- Ecological risks are limited primarily to benthic invertebrate (i.e., infaunal) community, softshell clams, and potentially blue crab; there are no risks to birds, mammals, or reptiles. These include bioaccumulative risks from 2,3,7,8-TCDD and PCBs, and direct toxicity risk to the benthic invertebrate community from a number of organic and inorganic chemicals. The areas where acute and chronic toxicity risks to the benthic invertebrate community were observed are limited in extent.

3.2.1 Baseline Human Health Risk Assessment Summary

A BHHRA was conducted for the NBSA (GSH 2019a) in accordance with USEPA risk assessment guidance. Human health risk was evaluated based on exposure to sediment or surface water or ingestion of biota in the NBSA. Two exposure scenarios were evaluated in the BHHRA: a reasonable maximum exposure (RME) and a central tendency exposure (CTE). These provide risk managers with a range of risks for an exposed population. Consumption by anglers of self-caught fish or blue crab from the NBSA is the only exposure pathway for which risk to human health exceeded risk ranges established in the National Contingency Plan (NCP; USEPA 1990). Both cancer risks and noncancer hazards are primarily due to concentrations of 2,3,7,8-TCDD and PCBs (both dioxin-like and non-dioxin-like congeners) in the

edible tissues of fish and crab (GSH 2019a). Risks from the consumption of fish and crab and the proportional contributions of 2,3,7,8-TCDD and PCBs to overall risk are summarized in Table 3-1.

The cumulative potential cancer risk for the RME fish or crab consumption scenario is $8x10^{-4}$ (combined adult/child angler) with the primary contributors being 2,3,7,8-TCDD and PCBs (Table 3-1). Both fish and crab CTE consumption cancer risk are within the NCP range. Cumulative potential noncancer risk hazard indices range from 2 to 40 (reproductive effects) depending upon exposure and are highest for child anglers.

Other compounds such as arsenic and pesticides that had minor contributions to the cumulative cancer risk or noncancer hazard index were within or below the NCP range. Therefore, human health based primary COCs for which PRGs will be established in the NBSA are 2,3,7,8-TCDD and total PCBs.

Table 3-1 Summary of Human Health Risks and Contributors

Risk Type	Diet	Central Tendency Exposure	Reasonable Maximum Exposure	Contribution from Primary Risk Drivers	
				2,3,7,8-TCDD	PCBs
Cancer Risk	Fish	$<10^{-4}$	$8x10^{-4}$	28%	55%
	Crab	$<10^{-4}$	$8x10^{-4}$	52%	31%
Noncancer Hazard Index	Fish	2	40	19%	56%
	Crab	4	30	44%	49%

3.2.2 Baseline Ecological Risk Assessment Summary

A BERA was conducted in the NBSA (GSH 2019b) in accordance with USEPA risk assessment guidance. Risks were evaluated for the following ecological receptors:

- Invertebrates (infaunal communities, softshell clam, and blue crab)
- Fish
- Birds
- Mammals
- Reptiles.

The results of the risk assessment indicate that risks to invertebrates are likely in the NBSA and there was little to no risk to other ecological receptors. Invertebrate risk was evaluated based on the comparison of tissue concentrations to toxicity reference values (TRVs) (clams, crabs) and based on a sediment quality triad (SQT) investigation for benthic invertebrate communities. Based on the tissue assessment, risk to softshell clams is possible mainly due to concentrations of 2,3,7,8-TCDD and PCBs that exceed TRVs. The SQT results indicate that portions of the NBSA are toxic to benthic invertebrate communities and that this toxicity is associated with a mixture of chemicals in sediments that include

metals, pesticides, PCBs, polycyclic aromatic hydrocarbons (PAHs), and dioxins/furans. Porewater concentrations exceeded water quality criteria or guidelines for total DDx (sum of dichlorodiphenyldichloroethane, dichlorodiphenyldichloroethylene, and dichlorodiphenyltrichloroethane isomers), PCBs, arsenic, PAHs, copper, and zinc, indicating the potential bioavailability of these chemicals at concentrations likely to cause toxicity. Presence in porewater at elevated concentrations and association with toxicity is used as a basis to derive sediment PRGs for a subset of potential risk drivers for acute toxicity in the NBSA, as described in Section 3.4. This list of primary COCs is as follows: 2,3,7,8-TCDD, PCBs, total DDx, arsenic, and total alkylated PAHs.

3.3 RAOs

The following three narrative RAOs have been developed for the NBSA.

- Human Health: Reduce cancer risks and noncancer health hazards for people eating fish and shellfish by reducing the concentrations of primary COCs in edible fish and shellfish tissues of the NBSA.
- Ecological Receptors: Reduce the risks to ecological receptors from direct contact to sediments and bioaccumulation by reducing the concentrations of primary COCs in the sediments of the NBSA.
- Contaminant Migration: Reduce the potential for export of primary COC-contaminated sediments from the NBSA to connected waterways.

3.4 PRGs

PRGs for the NBSA will be sediment-based and will represent the concentrations that may be left in place on a surface-weighted basis in order to achieve RAOs. Based on human health risk, acceptable levels in tissue will be used to calculate sediment PRGs based on the bioaccumulation model in development for the NBSA for the primary COCs, 2,3,7,8-TCDD and PCBs. Based on ecological risk, PRGs were developed to address local areas of benthic invertebrate community direct exposure risk (i.e., toxicity) using the results of the SQT assessment from the BERA.

3.4.1 Sediment PRGs for the Protection of Human Health

Sediment PRGs are established by first calculating acceptable concentrations in fish and crab tissue that are protective of the angler consuming self-caught fish from the NBSA. The bioaccumulation model currently under development by the USEPA for the NBSA will then be used to estimate the average sediment concentration in the NBSA that would result in achieving acceptable tissue concentrations.

Based on the exposure scenarios evaluated in the BHHRA in accordance with USEPA guidance, acceptable levels in fish and crab tissue are provided in Table 3-2. While the RME and CTE scenarios provide a range of risks, the USEPA generally bases risk management decisions on the RME scenario (USEPA 1989). The RME noncancer hazard-based acceptable tissue levels are lower than the 10^{-4} cancer risk-based concentrations, therefore these values, shown in bold in Table 3-2, will be the basis for sediment PRG development.

Table 3-2 Fish and Crab Concentrations Protective of the Angler

Diet	Chemical (µg/kg)	Receptor	Cancer Risk-Based Tissue Concentrations						Noncancer Hazard-Based Tissue Concentration		Current EPC in the NBSA[a]
			RME			CTE			RME	CTE	
			10^{-6}	10^{-5}	10^{-4}	10^{-6}	10^{-5}	10^{-4}	HI=1		
Fish	2,3,7,8-TCDD	Adult	0.000054	0.00054	0.0054	0.0016	0.016	0.16	**0.0016**	0.022	0.0082
		Child	0.00011	0.0011	0.0115	0.0031	0.031	0.31	**0.0010**	0.014	
	Total PCBs	Adult	4.0	40	405	224	2,245	22,447	**46**	577	408
		Child	8.6	86	860	429	4,293	42,929	**29**	368	
Crab	2,3,7,8-TCDD	Adult	0.000089	0.00089	0.0089	0.0014	0.014	0.14	**0.0027**	0.019	0.026
		Child	0.00019	0.0019	0.019	0.0026	0.026	0.26	**0.0017**	0.012	
	Total PCBs	Adult	6.7	67	670	207	2,074	20,741	**77**	533	320
		Child	14	142	1,423	397	3,967	39,667	**49**	340	

Notes:
[a]The EPC for fish is based on a weighted average of a mixed fish diet evaluated in the BHHRA, which consists of equal weights of the following five species: American eel, bluefish, striped bass, summer flounder and white perch. The EPC for crab is based on the average muscle/hepatopancreas concentrations evaluated in the BHHRA.
Values in bold represent the tissue levels to be used for sediment PRG development.
EPC = exposure point concentration
HI = hazard index
µg/kg = micrograms per kilogram

A bioaccumulation model for the NBSA is currently under development by the USEPA. The model will be used to forecast tissue concentrations based on sediment concentrations in the future under various alternatives. The model is based on a Gobas food web model (Arnot and Gobas 2004) and will be combined with output from the contaminant fate and transport model for the NBSA (HDR 2019). Sediment PRGs will be developed such that based on model predictions, they will result in acceptable tissue levels being achieved in the NBSA. The model under development is being calibrated to estimate tissue concentrations for 2,3,7,8-TCDD and for total tetra-chlorinated biphenyls (i.e., PCBs with four chlorine substitutions). A protective level for total tetra-chlorinated biphenyls in tissue will be developed based on the average ratio of total tetra-chlorinated biphenyls to total PCBs found in tissue data (or a regression relationship). Based on the model, a protective sediment level will be developed for total tetra-chlorinated biphenyls. Based on the average ratio of total tetra-chlorinated biphenyls to total PCBs (or a regression relationship) found in current surface sediment data in the NBSA (i.e., Phase III sediment data), a PRG will be calculated for total PCBs and individual PCB congeners, as needed.

The bioaccumulation model will provide predictions of tissue concentrations for the five species evaluated in the mixed fish diet in the BHHRA: American eel, bluefish, striped bass, summer flounder, and white perch. Model-predicted protective levels for sediment will be developed under the assumption of a mixed fish diet by anglers comprising equal amounts of each of the five species. Model-predicted protective levels for sediment will also be developed under the assumption of a crab diet (muscle/hepatopancreas). The sediment PRGs will be the value that is the smaller of the protective sediment concentrations for either a fish or a crab diet. The bioaccumulation model is designed to work with the contaminant fate and transport model to predict tissue concentrations within each of three spatial (i.e., exposure) units within the NBSA: north, southeast, and southwest. These units are consistent with the spatial units (i.e., assessment zones) evaluated in the BERA. Depending on the outcome of predicted tissue

concentrations, for example, if they are very different compared to sediment concentrations within each spatial unit, sediment PRGs may be developed separately for each of the three units.

3.4.2 Sediment PRGs for the Protection of Benthic Invertebrates

3.4.2.1 Benthic Invertebrate Toxicity

As detailed in the BERA, there was evidence of risk to the benthic invertebrate community in the NBSA, particularly in the southwestern subtidal flats. To understand and evaluate this risk, a SQT investigation was implemented. The SQT program included the following elements where data were collected synoptically at 30 stations: 1) sediment and porewater chemistry; 2) toxicity testing using the 10-day and 28-day amphipod (i.e., *Leptocheirus plumulosus*) bioassay; and 3) benthic invertebrate community taxa enumeration. The data are described and evaluated in the BERA (GSH 2019b). The evaluation was a two-pronged approach: 1) comparison of data to published values (e.g., sediment quality guidelines and water quality criteria for aquatic life) or comparison to a reference site; and 2) a statistically based exposure-effects assessment. Acute toxicity, based on 10-day amphipod survival, was observed at two of the 30 SQT stations: stations 151 and 154 located in the southwest subtidal flats (Figure 3-1). Chronic toxicity, defined here as 28-day amphipod survival significantly different than control, was observed at these stations as well as four others, two in the northern (i.e., 158 and 160) and two in the southeastern BERA assessment zones (i.e., 141 and 143) of the NBSA (Figure 3-1). Neither sediment nor porewater chemistry were found to be associated with impact to the benthic invertebrate community metrics such as abundance, richness, diversity, etc.; therefore, only toxicity is considered in the determination of PRGs.

Based on multivariate statistical analyses presented in the BERA (GSH 2019b), both acute and chronic toxicity were found to be associated with complex chemical mixtures in sediment and porewater. Toxicity occurred in samples with elevated concentrations of multiple chemicals including dioxins/furans; PCBs; pesticides (particularly total DDx, dieldrin, chlordane, and hexachlorobenzene); PAHs (both parent and alkylated); petroleum hydrocarbons; and most metals (e.g., arsenic, cadmium, chromium, copper, lead, mercury, and zinc). It is challenging to ascribe causation based on bulk sediment concentrations because in addition to being correlated with toxicity and each other, all of these chemicals were found to exceed sediment quality guidelines. Therefore, porewater concentrations, which were collected for the BERA to more accurately assess likely bioavailability, were used to select a subset of chemicals that are the most likely drivers of toxicity and for which PRGs can be derived.

In its derivation of equilibrium partitioning sediment benchmarks for the protection of benthic organisms, the USEPA (2003) conducted ancillary analyses that suggest the sensitivity distribution of benthic and epibenthic organisms is not significantly different from that of pelagic organisms; therefore, aquatic life water quality criteria (WQC) applied to porewater should be fully protective of benthic organisms. As part of the SQT evaluation presented in the BERA (GSH 2019b), porewater concentrations were compared to WQC for the protection of aquatic life in saline waters (New Jersey Department of Environmental Protection [NJDEP] 2016)[1]. The WQC were exceeded for the following chemicals in porewater: total (4,4') DDx, total PCBs, arsenic, copper, and zinc. In addition, based on the narcosis model of PAH toxicity

[1] For chemicals in which WQC were not available (e.g., 2,3,7,8-TCDD, hexachlorobenzene) other conservative water quality guidelines (Buchman 2008) were used for comparison, however none were exceeded.

(USEPA 2017), risk was also demonstrated for PAHs in porewater where the sum of toxic units (SumTU), a unitless toxicity weighted sum of 34 PAHs, including both parent and alkylated PAHs, was greater than or equal to 1, the value at which the potential for toxicity is expected. The resulting subset of chemicals from the porewater evaluation is the basis for derivation of PRGs for the protection of benthic invertebrates.

Proposed sediment-based PRGs were developed based on the likelihood of concentrations to result in acute toxicity to benthic invertebrate communities in the NBSA. In the following discussion, evidence of chronic toxicity, while not used to derive PRGs, is considered as potential evidence that a chemical is contributing to acute toxicity in the NBSA. All of the data, data comparisons, and correlation analyses described below are detailed in Appendix A of the BERA (GSH 2019b). PRGs were developed for total DDx, PCBs, PAHs, and arsenic and are based on probit dose response models developed for each chemical using the 10-day amphipod mortality toxicity endpoint (Figure 3-2a-d). The PRG is defined as the concentration at which 10-day survival is predicted to be less than 80% of control, the definition of toxicity employed in the BERA. This corresponds to excess mortality (i.e., mortality beyond the control threshold value of 10%) of 20%. The PRGs are rounded down from the model-predicted value and expressed in 2 significant figures in Table 3-3. PRGs were not developed for copper and zinc for reasons described below.

Total DDx

Total (4,4') DDx exceeded chronic WQC in 14 porewater samples, five of which exhibited chronic toxicity and two of which exhibited acute toxicity. Total DDx in both sediment and porewater was significantly correlated with acute and chronic toxicity endpoints. Total DDx was most elevated in both sediment and porewater at the two acutely toxic SQT stations. A PRG was derived for total DDx expressed as the sum of all six isomers, total (2,4' and 4,4') DDx. The dose response model predicts acute toxicity at a concentration of 428 micrograms per kilogram (µg/kg) of total (2,4' and 4,4') DDx in sediment (Figure 3-2a). The PRG for the protection of benthic invertebrate communities is set at 420 µg/kg (Table 3-3).

PCBs

Total PCBs (sum of 209 congeners) exceeded chronic WQC in three porewater samples, two of which exhibited acute toxicity. Total PCBs (and individual congeners) in both sediment and porewater were significantly correlated with acute and chronic toxicity endpoints. Total PCBs was most elevated in both sediment and porewater at the acutely toxic station 151 (Figure 3-1). The second highest concentration in sediment was observed at station 160, which while not exhibiting acute toxicity, did exhibit chronic toxicity and complete mortality at 28 days. The third highest concentration in sediment was observed at station 154. The dose response model predicts acute toxicity at a concentration of 1,707 µg/kg total PCBs in sediment (Figure 3-2b). The PRG for the protection of benthic invertebrate communities is set at 1,700 µg/kg (Table 3-3).

PAHs

Two porewater samples exhibited PAH concentrations in which the SumTU was greater than or equal to 1 and both locations were acutely toxic. All PAHs in porewater, both parent and alkylated, were significantly correlated with acute and chronic toxicity endpoints. In sediment, however, only the alkylated PAHs, both individual and expressed as a sum (i.e., total alkylated PAHs) were significantly correlated with toxicity. An examination of the individual PAHs that make up the SumTU at stations 151 and 154

indicate that 84% and 90%, respectively, of the SumTU value is comprised of toxic units of alkylated PAHs. This strongly suggests that it is the alkylated PAHs that are contributing to the toxicity at these stations. As such, PRGs were derived for total alkylated PAHs (i.e., the sum of 18 alkylated PAHs) rather than total PAHs (i.e., the sum of 17 parent PAHs). The dose response model predicts acute toxicity at a concentration of 29,100 µg/kg total alkylated PAHs in sediment (Figure 3-2c). The PRG for the protection of benthic invertebrate communities is set at 29,000 µg/kg (Table 3-3).

Arsenic

Arsenic exceeded chronic WQC in three porewater samples and acute criteria in one sample all of which exhibited toxicity. Arsenic was most elevated in both sediment and porewater at the acutely toxic station 151. The second highest concentration in porewater (but not sediment) was observed at station 160, which while not exhibiting acute toxicity, did exhibit chronic toxicity and complete amphipod mortality at 28 days. The second highest concentration in sediment was observed at station 154; although, arsenic was not detected in porewater at this station. The third highest concentration in both sediment and porewater was observed at station 143 where chronic toxicity was also exhibited. The dose response model predicts acute toxicity at a concentration of 34.4 milligrams per kilogram (mg/kg) arsenic in sediment (Figure 3-2d). The PRG for the protection of benthic invertebrate communities is set at 34 mg/kg (Table 3-3).

Copper and Zinc

Copper was detected in porewater at five SQT stations, one of which (i.e., 147) exceeded acute WQC and another (i.e., 163) which exceeded chronic WQC. Acute toxicity was not observed at these locations and 28-day survival was fairly high at both. While copper in sediment had the highest concentrations at the two acutely toxic stations (Table 3-3), it was not detected in the porewater at those stations. Therefore, there is considerable uncertainty whether copper is causing toxicity at those stations.

Zinc was detected in porewater at only three SQT stations (i.e., 141, 150, and 159), all at concentrations that exceeded acute WQC. Chronic toxicity was observed at one of these stations (141) where the sediment concentration was 231 parts per million. The other two stations had fairly high 28-day survival and none of the three stations were acutely toxic. While zinc was elevated at the two acutely toxic stations (Table 3-3), it was not detected in the porewater at those stations. Therefore, there is considerable uncertainty whether zinc is causing toxicity at those stations.

Copper and zinc were also evaluated in the BERA (GSH 2019b) as part of a simultaneously extracted metal mixture in sediment per USEPA guidance (USEPA 2005). This guidance explains that acid volatile sulfide in sediments binds to divalent metals (i.e., cadmium, copper, lead, nickel, and zinc) such that they are not bioavailable in sediments and, therefore, are non-toxic to benthic organisms. Results of the evaluation suggest that these metals are not bioavailable at the acutely toxic stations, 151 and 154. Metal mixtures in porewater were also evaluated according to USEPA guidance (USEPA 2005) with a SumTU approach. Cadmium and nickel were not detected in porewater; therefore, the SumTU was based on detections of copper, lead, and zinc only. SumTU exceeded 1 at six SQT stations (i.e., 139, 159, 163, 141, 147, and 150), one of which also exhibited chronic toxicity based on 28-day survival (141). However, none of these metals were detected in porewater at the acutely toxic stations.

Because the evidence is uncertain whether copper and zinc are contributing to the acute toxicity observed in the NBSA, PRGs were not derived for these metals.

Table 3-3 Summary of Sediment PRGs for the Protection of the Benthic Invertebrate Community

Chemical	Units	Concentrations at Acutely Toxic Stations		Model-Predicted Value above which 10-day Survival is Predicted to be less than 80% of Control	Proposed Sediment PRG for the Protection of Benthic Invertebrates
		151	154		
Total (2,4' and 4,4') DDx	µg/kg	600	560	428	420
Total PCB Congeners	µg/kg	4,370	1,120	1,707	1,700
Total Alkylated PAHs[a]	µg/kg	30,400	37,800	29,100	29,000
Arsenic	mg/kg	61.5	30.9[b]	34.4	34
Copper	mg/kg	567[b]	545[b]	--	--
Zinc	mg/kg	681[b]	570[b]	--	--

Notes
[a]Sum of C1-Chrysenes, C1-Fluoranthenes/Pyrenes, C1-Fluorenes, C1-Naphthalenes, C1-Phenanthrenes/Anthracenes, C2-Chrysenes, C2-Fluoranthenes/Pyrenes, C2-Fluorenes, C2-Naphthalenes, C2-Phenanthrenes/Anthracenes, C3-Chrysenes, C3-Fluoranthenes/Pyrenes, C3-Fluorenes, C3-Naphthalenes, C3-Phenanthrenes/Anthracenes, C4-Chrysenes, C4-Naphthalenes, and C4-Phenanthrenes/Anthracenes.
[b]Not detected in porewater at this location.
-- A PRG was not derived for this chemical since evidence of toxicity being caused by its presence in porewater could not be demonstrated.

3.4.2.2 Invertebrate Bioaccumulation Risk

As detailed in the BERA, there is risk to softshell clams due to the bioaccumulation of 2,3,7,8-TCDD and PCBs from sediments. The toxicity reference values that indicate risk are given in Table 3-4. The bioaccumulation model described in Section 3.4.1 will be used to derive sediment PRGs that are concentrations that would result in acceptable tissue concentrations in the softshell clam. Sediment PRGs will be developed such that based on model predictions, they will result in acceptable clam tissue levels being achieved in the NBSA. The model under development is being calibrated to estimate tissue concentrations for 2,3,7,8-TCDD and for total tetra-chlorinated biphenyls (i.e., PCBs with four chlorine substitutions). A protective level for total tetra-chlorinated biphenyls in clam tissue will be developed based on the average ratio of total tetra-chlorinated biphenyls to total PCBs found in clam tissue data (or a regression relationship). Based on the model, a protective sediment level will be developed for total tetra-chlorinated biphenyls. Based on the average ratio of total tetra-chlorinated biphenyls to total PCBs (or a regression relationship) found in current surface sediment data in the NBSA (i.e., Phase III sediment data), a PRG will be calculated for total PCBs and individual PCB congeners, as needed.

Table 3-4 Tissue Concentrations Protective of Softshell Clam

Chemical	Tissue Concentration (µg/kg)	Basis	Literature Source
2,3,7,8-TCDD	0.002	Lowest observed effect level for bivalve (oyster and softshell clam) reproduction	Cooper and Wintermyer (2009)
Total PCBs	26	Lowest observed effect level for Eastern oyster reproduction	Chu et al. (2000), Chu et al. (2003)

3.4.3 Summary

A summary of the sediment PRGs being established separately to address human health and ecological risks in the NBSA is shown in Table 3-5. Sediment PRGs for the protection of human health will be derived based on the tissue levels protective of the angler consuming self-caught fish in the NBSA (Table 3-2). Sediment PRGs for 2,3,7,8-TCDD and total PCBs will be based on predictions of protective tissue concentrations using the bioaccumulation model currently under development by the USEPA.

Proposed sediment PRGs were derived for sediment to protect benthic invertebrate communities from bioavailable concentrations of chemicals for which there is evidence are contributing to acutely toxic conditions in the NBSA. This evidence is based on both the chemical's presence in sediments at elevated concentrations and its presence in porewater in exceedance of WQC. Proposed PRGs were derived for the following primary COCs: total DDx (2,4' and 4,4'), total PCBs (sum of 209 congeners), total alkylated PAHs, and arsenic (Table 3-3). Additional sediment PRGs will be derived for 2,3,7,8-TCDD and total PCBs based on the bioaccumulation risk in softshell clams (Table 3-4) using the bioaccumulation model.

These PRGs will be used as the basis to establish the extent of sediment subject to remediation and develop the alternatives to be evaluated in the detailed and comparative analysis. Sediment PRGs to be developed based on the bioaccumulation modeling will be submitted in tabular form under separate cover once the calibrated model is complete.

Table 3-5 Summary of PRGs

Risk Basis	COC	Units	Acceptable Tissue Concentration	Sediment PRG	Notes
Human Health: Fish/Crab Consumption	2,3,7,8-TCDD	µg/kg	0.0016 / 0.0027	TBD	Sediment PRGs will be developed based on the bioaccumulation model predictions for fish and crab tissue.
	Total PCBs	µg/kg	46 / 77	TBD	
Bioaccumulation Risk: Softshell Clam	2,3,7,8-TCDD	µg/kg	0.002	TBD	Sediment PRGs will be developed based on the bioaccumulation model predictions for clam tissue.
	Total PCBs	µg/kg	26	TBD	
Risk of Toxicity to the Benthic Invertebrate Community	Total DDx (2,4' and 4,4')	µg/kg	NA	420	Sediment PRGs derived from dose response models of acute toxicity (i.e., 10-day amphipod survival) vs. sediment concentration.
	Total PCBs	µg/kg	NA	1,700	
	Total Alkylated PAHs	µg/kg	NA	29,000	
	Arsenic	mg/kg	NA	34	

Notes
TBD = To be developed
NA = not applicable

4 NEXT STEPS

This RAO/PRG Tech Memo documents the results of Task 1 (Description of Remedial Action Objectives and Preliminary Risk-Based Remediation Goals) in the FS WP. The ARARs, RAOs, and PRGs resulting from Task 1 will be used to form the basis for the remedial alternatives to be evaluated in the FS Report.

The next step in the process includes finalizing the sediment PRGs to address potential human health and ecological risk. As noted in Section 3, at this time only PRGs for ecological risks can be developed using the BERA and SQT; PRGs specific to human health risks and bioaccumulation risk for softshell clams will require completion of the bioaccumulation modeling and associated calibration. Finalizing the PRGs is key in developing the remedial alternatives. Following USEPA approval of the RAOs and PRGs, the PRGs will be applied to identify the areas of sediment potentially subject to remediation. Areas subject to remediation are likely to include the preliminarily identified focus areas (i.e., southwest subtidal flats, northern navigational channels, and areas near bridge piers). Rationale will be developed to support selection of the focus areas for review and discussion with USEPA. Determining the areas for remedial consideration will then lead to alternative development and evaluation.

An additional technical memorandum will be developed to describe the Identification of Candidate Technologies (ICT) and Remedial Alternatives Screening (RAS) as outlined in the FS WP. This memorandum will include the components summarized below.

- ICT will include developing general response actions, technology types, and process options. This will be completed primarily in tabular format with each potentially applicable technology type and process option screened based on effectiveness, implementability, and relative cost. The retained representative process options will be used to develop a list of initial alternatives for the RAS. The ICT includes Task 5: Technology Identification & Treatability Studies. At this time, no treatability studies are planned as part of the NBSA FS process.
- RAS will include a description of the current situation, development of alternatives, and the initial screening of alternatives. The focus areas approved by USEPA will be integrated into the alternative development process. A table will be developed to perform the initial screening of potential remedial alternatives based on effectiveness, implementability, and relative cost. Retained alternatives will be brought into the draft FS to undergo the detailed and comparative analyses. The RAS will include the following tasks from the FS WP:
    - Task 1: Description of Remedial Action Objectives and Preliminary Risk-Based Remediation Goals – summary of RAOs and PRGs only
    - Task 2: Description of Current Situation and Proposed Response
    - Task 3: Development of Alternatives
    - Task 4: Initial Screening of Alternatives

The findings and results from the RAO/PRG and ICT/RAS Technical Memoranda (FS WP Tasks 1 through 5) will be used to perform FS WP Task 6: Detailed Evaluation of Alternatives. This evaluation will include analysis of the potential remedial alternatives using the nine CERCLA criteria. FS WP Task 7 includes Preparation of the Draft and Final FS Report.

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TABLES

Table 2-1: Location-Specific Applicable Relevant and Appropriate Requirements (ARARs)

Newark Bay Study Area, Newark Bay, New Jersey
Remedial Action Objectives & Preliminary Remedial Goals Technical Memorandum

Act/Regulation	Citation	ARAR	General Description
Federal ARARs			
Coastal Zone Management Act	16 USC §§ 1451-1465; 15 CFR Parts 923 and 930	ARAR	Establishes that Federal agencies that conduct or support activities that directly affect a coastal use or resource must undertake those activities in a manner that is consistent, to the maximum extent practicable, with State coastal zone management programs. The goal is to "preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone."
Endangered Species Act	16 USC §§ 1531-1544; 50 CFR Part 17, Subpart I; 50 CFR Part 402	ARAR	Establishes that Federal agencies are required to verify that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of any endangered species or threatened species, or result in the destruction or adverse modification of a critical habitat of such species, unless such agency has been granted an appropriate exemption by the Endangered Species Committee.
Bald and Golden Eagle Protection Act	16 USC §§ 668	ARAR	Prohibits anyone, without a permit issued by the Secretary of the Interior, from knowingly taking and disturbing any bald eagle (commonly known as the American eagle), any golden eagle, or associated nest and/or egg. (Not included in LPR FFS.)
Migratory Bird Treaty Act	16 U.S.C. §703	ARAR	Requires that Federal agencies consult with the United States Fish & Wildlife Service to ensure that the cleanup of the site does not unnecessarily impact migratory birds.
Fish and Wildlife Coordination Act	16 USC §§ 662	ARAR	Requires the lead agency to develop measures to prevent "loss of and damage to" fish and wildlife resources "whenever the waters of any stream or other body of water are proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose whatsoever." This includes any department or agency of the United States, and such department or agency first shall consult with the United States Fish & Wildlife Service, Department of the Interior, and with the head of the agency exercising administration over the wildlife resources of the particular State in which the impoundment, diversion, or other control facility is to be constructed, with a view to the conservation of wildlife resources by preventing loss of and damage to such resources.
Magnuson-Stevens Fishery Conservation and Management Act	Public Law 94-265, as amended through October 11, 1996	ARAR	Legal provision for promoting optimal exploitation of U.S. coastal fisheries. Requires that Federal agencies consult with NMFS on actions that may adversely affect essential fish habitats, defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."
National Historic Preservation Act	16 USC §§ 470 – 470x-6; 36 CFR Part 800	ARAR	Establishes that response actions must consider effect on properties currently listed or eligible for inclusion on the National Registry of Historic Places. Requires Federal agencies to consider the effects of their undertakings on historic properties and afford the Council a reasonable opportunity to comment on such undertakings. This will include consultation with State and local governments, Indian tribes, and private organizations as necessary.

Table 2-1: Location-Specific Applicable Relevant and Appropriate Requirements (ARARs)

Newark Bay Study Area, Newark Bay, New Jersey
Remedial Action Objectives & Preliminary Remedial Goals Technical Memorandum

Act/Regulation	Citation	ARAR	General Description
Floodplain Management	Executive Order 11988, 40 CFR Part 6	ARAR	Floodplain management requires Federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid, to the extent possible, adverse effects associated with direct and indirect development of a floodplain. Federal agencies are required to avoid adverse impacts or minimize them if no practicable alternative exists. (LPR FFS identified as a TBC.)
Protection of Wetlands	Executive Order 11990, 40 CFR Part 6	ARAR	Protection of wetlands requires Federal agencies conducting certain activities to avoid, to the extent possible, adverse impacts associated with the destruction or loss of wetlands if a practicable alternative exists. Federal agencies are required to avoid adverse impacts or minimize them if no practicable alternative exists. (LPR FFS identified as a TBC.)
State ARARs			
NJDEP New Jersey Freshwater Wetlands Protection Act	N.J.S.A. 13:9B-1, N.J.A.C. 7:7A	ARAR	Describes the activities that may and may not be conducted in and adjacent to freshwater wetlands and State open waters. Act passed to "preserve the purity and integrity of freshwater wetlands from random, unnecessary or undesirable alteration or disturbance." Regulates construction or other activities (including remedial action) that will have an impact on wetlands, including working and transporting across coastal zone to upland processing facility.
NJDEP New Jersey Flood Hazard Area Control Act	N.J.S.A. 58:16A-50, N.J.A.C. 7:13	ARAR	Regulates activities (including remedial action) within flood hazard areas that will impact stream carrying capacity or flow velocity to avoid increasing impacts of flood waters, to minimize degradation of water quality, protect wildlife and fisheries, and protect and enhance public health and welfare. Incorporates standards for development in flood hazard areas and adjacent to surface waters in order to mitigate the adverse impacts to flooding and the environment that can be caused by such development.
NJDEP New Jersey Tidelands Act	N.J.S.A. 12:3	ARAR	Requires a tidelands lease, grant or conveyance for use of State-owned riparian lands, including sediment removal and backfill. Tidelands (riparian lands) are all those lands now or formerly flowed by the mean high tide of a natural waterway, except for those lands for which the State has already conveyed its interest in the form of a riparian grant.
New Jersey Endangered Species Act	N.J.S.A. 23:2A *et seq*	ARAR	The law is designed to protect species whose survival in New Jersey is imperiled by loss of habitat, over-exploitation, pollution, or other impacts. The act establishes a list of wildlife species designated by the State of New Jersey as threatened and endangered. The law prohibits taking, possessing, transporting, exporting, processing, selling, or shipping listed species. "Take" is defined by the law as harassing, hunting, capturing, or killing, or attempting to do so. (Not included in LPR FFS.)
New Jersey Endangered Plant Species List Act	N.J.S.A. 7:5C-1.1 *et seq.*	ARAR	Establishes an official list of endangered plants that fall under the protected status. (Not included in LPR FFS.)

Table 2-1: Location-Specific Applicable Relevant and Appropriate Requirements (ARARs)

Newark Bay Study Area, Newark Bay, New Jersey
Remedial Action Objectives & Preliminary Remedial Goals Technical Memorandum

Act/Regulation	Citation	ARAR	General Description
NJDEP New Jersey Coastal Zone Management and New Jersey Waterfront Development Law	N.J.A.C. 7:7E, New Jersey Coastal Permit Program, N.J.A.C. 7:7; N.J.S.A. 12:5-3;	ARAR	Establishes the rules for the use and development of coastal resources within New Jersey's coastal zone. Regulates any waterfront development, including sediment removal and fill, at or below mean high water and up to 500 feet from mean high water in the coastal zone and tidal waters of the State.
NJDEP New Jersey Register of Historic Places Act	N.J.S.A. 13:1B-15.128 et seq.	ARAR	Requires consultation with the New Jersey Historic Preservation Office and other parties to develop ways to avoid, reduce, minimize, or mitigate any adverse impacts to any district, site, building, structure or object included in, or eligible for inclusion in, the National Register of Historic Places.
NYSDEC Natural Heritage Program (Division of Fish and Wildlife and Division of Marine Resources)	6 NYCRR Part 182	ARAR	Requires regulatory consultation to determine if any resources in the area. (Not included in LPR FFS.)
NYSDEC Critical Environmental Areas (Division of Environmental Permits)	6 NYCRR 617.14(g)	ARAR	Requires regulatory consultation to determine if any critical environmental areas in the project area. (Not included in LPR FFS.)
NYSDEC Tidal Wetlands	Article 25 ECL; 6 NYCRR Part 661	ARAR	Assess work within NYS tidal wetlands to determine if adverse impacts associated with the destruction or loss of wetlands if a practicable alternative exists. Federal agencies are required to avoid adverse impacts or minimize them if no practicable alternative exists. (Not included in LPR FFS.)
NYSDEC Protection of Waters	Article 15 ECL; 6 NYCRR Part 608	ARAR	Assess work within NYS waterways to determine if adverse impacts associated with the destruction or loss of wetlands if a practicable alternative exists. Federal agencies are required to avoid adverse impacts or minimize them if no practicable alternative exists. (Not included in LPR FFS.)
New York Endangered Species Act	Article 11, Title 5; 6 NYCRR Part 182	ARAR	Lists endangered, threatened species and species of special concern. The taking of any endangered or threatened species is prohibited except under a permit or license issued by NYSDEC. The NYSDEC must be consulted for a determination of whether an activity is likely to result in the incidental take of a listed species. (Not included in LPR FFS.)
New York State Protected Native Plants	Article 9, Title 16; 6 NYCRR Part 193	ARAR	Lists endangered, threatened, rare, and exploitable vulnerable native plants. All listed species are "protected plants" and may not be removed or damaged without consent of the owner. (Not included in LPR FFS.)
Coastal Zone Management Act; NYS Waterfront Revitalization and Coastal Resources Act	Article 42: (910 – 923)	ARAR	Assessment of the NYSDOS Coastal Management Program Consistency Determination if project is consistent with coastal program.

Table 2-1: Location-Specific Applicable Relevant and Appropriate Requirements (ARARs)

Newark Bay Study Area, Newark Bay, New Jersey
Remedial Action Objectives & Preliminary Remedial Goals Technical Memorandum

Act/Regulation	Citation	ARAR	General Description
Section 106 of the National Historic Preservation Act	36 CFR 800	ARAR	Confer with NYSOPRHP Cultural Resource to assess whether cultural resource impacts resulting from the project.
NYSOGS	9 NYCRR 274	ARAR	Review of water index mapping to determine if any State underwater land approval is required for work in State underwater lands.

Note: The table provides the list of preliminary Federal and State location specific ARARs for the NBSA. There were no location-specific TBCs identified. The listed ARARs, references, and descriptions have been pulled from the ARARs and TBCs outlined in the LPR FFS (USEPA 2014) due to the contiguous relationship between the two waterbodies and various OUs of the of Site (see specifically Table 2-1a). Additional ARARs have been added beyond the LPR FFS due to potential applicability for the NBSA (these are noted under the General Description).

Acronyms and Abbreviations:
ARAR = applicable or relevant and appropriate requirements
CFR = Code of Federal Regulations
ECL = Environmental Conservation Law
LPR FFS = Focused Feasibility Study for OU2 in the Lower Passaic River
NBSA = Newark Bay Study Area
NJ = New Jersey
NJDEP = New Jersey Department of Environmental Protection
N.J.A.C. = New Jersey Administrative Code
N.J.S.A. = New Jersey Statutes Annotated
NMFS = National Marine Fisheries Service
NYCRR = New York Code of Rules and Regulations
NYS = New York State
NYSDEC = New York State Department of Environmental Conservation
NYSDOS = New York State Department of State
NYSOGS = New York State Office of General Services
NYSOPRHP = NYS Office of Parks, Recreation & Historic Preservation
TBC = to be considered criteria
U.S.C. = United States Code

Table 2-2: Action-Specific Applicable Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBCs)

Newark Bay Study Area, Newark Bay, New Jersey
Remedial Action Objectives & Preliminary Remedial Goals Technical Memorandum

Act/Regulation	Citation	ARAR or TBC	General Description
Federal ARARs and TBCs			
CWA	Section 401 WQC	ARAR	CWA §401 requires that an applicant for an USACE permit to conduct an authorized activity that may result in any discharge to navigable waters to provide the federal permitting agency (e.g., USACE) a water quality certification from the NJDEP and NYSDEC.
	Section 404	ARAR	CWA §404 regulates the discharge of dredged or fill material into waters of the U.S. No discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge, which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. If there is no other practical alternative, impacts must be minimized. This program is implemented through regulations set forth in 33 CFR Parts 320 through 330 and 40 CFR Part 230.
	40 CFR Parts 230 [Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material]	ARAR	Guidelines for Specification of Disposal Sites for Dredged or Fill Material
Rivers and Harbors Act (Section 10)	33 USC § 403; 33 CFR Parts 320-330	ARAR	Prohibits unauthorized obstruction or alteration of any navigable water in the U.S. (dredging, fill, cofferdams, piers, etc.). USACE approval is required to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of the channel of any navigable water of the U.S.
CAA	42 USC §§ 7401 et seq; 40 CFR Parts 50-63	ARAR	Establishes emissions standards for the following pollutants: lead, N, CO, O_3, PM_{10}, and SO_2. Establishes emissions standards for hazardous air pollutants, which can contribute to air pollution, to protect the public health from such pollutants.
RCRA	42 U.S.C. § 6921 et seq; 40 CFR Parts 239 – 299	ARAR	Establishes requirements for generators, transporters, and facilities that manage non-hazardous solid waste and hazardous wastes. Provides for evaluation and control of materials that contain a listed waste, or that display a hazardous waste characteristic based on the TCLP test. Regulates storage, treatment and disposal of listed or characteristic waste unless an exemption applies. Specifies TCLP constituent levels for identifying wastes that exhibit toxicity characteristics. Includes manifest, record keeping and other requirements applicable to generators of hazardous waste. Sets forth standards for transporters of hazardous wastes, including the receipt of an USEPA identification number and manifesting requirements. Provides management standards including record keeping, requirements for units such as tanks or containers, and other requirements applicable to owners and operators of hazardous waste treatment, storage, and disposal facilities. Places land disposal restrictions, including treatment standards

Table 2-2: Action-Specific Applicable Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBCs)

Newark Bay Study Area, Newark Bay, New Jersey
Remedial Action Objectives & Preliminary Remedial Goals Technical Memorandum

Act/Regulation	Citation	ARAR or TBC	General Description
			and related testing, tracking and record keeping requirements, on hazardous waste(s).
USEPA OSR	40 CFR 300.440	ARAR	Requires that CERCLA wastes be placed in a facility operating in compliance with the RCRA or other applicable federal or state requirements. (Not included in LPR FFS.)
TSCA	15 U.S.C. §§ 2601 et seq.; 40 CFR Part 761	ARAR	Provides regulations for storage, handling, and disposal of sediment containing PCBs greater than 50 milligrams per kilogram.
Hazardous Materials Transportation Act	49 CFR Part 171-177	ARAR	Provides transportation and handling requirements of hazardous materials to off-site disposal facilities.
USEPA Remedial Design/Remedial Action Handbook	EPA 540-R-95-059 OSWER Directive 9355.0-4B	TBC	General reference manual that provides remedial project managers with an overview of the remedial design and remedial action processes. (Not included in LPR FFS.)
Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites	OSWER Directive 9285.6-08	TBC	Guidance document that helps USEPA site managers make scientifically sound and nationally consistent risk management decisions at contaminated sediment sites. (Not included in LPR FFS.)
Contaminated Sediment Remediation Guidance for Hazardous Waste Sites	EPA 540-R-05-012 OSWER 9355.0-85	TBC	Guidance document that provides technical and policy guidance for project managers and management teams making remedy decisions for contaminated sediment sites. (Not included in LPR FFS.)
State ARARs and TBCs			
NJPDES	N.J.A.C. 7:14A	ARAR	Regulates the discharge of pollutants to the surface and ground waters of the State. Details the specific permit requirements and effluent standards for the discharge to the waters of New Jersey.
New Jersey Water Pollution Control Act New Jersey Water Quality Planning Act, and New Jersey Surface Water Quality Standards	N.J.S.A. 58:10A, et seq.; N.J.S.A 58:11 A, et seq.; N.J.A.C. 7:9B	ARAR	Establishes the designated uses and antidegradation categories of the State's surface waters, classifies surface waters based on those uses (i.e., stream classifications), and specifies the water quality criteria and other policies and provisions necessary to attain those designated uses. Protects surface water resources. Contains stream classifications, water designated uses, water quality criteria to protect uses, antidegradation policies, and procedures for implementing water quality standards.
NJ Stormwater Management Rules	N.J.A.C. 7:8	ARAR	Establishes the design and performance standards for stormwater management measures. Contains general requirements for stormwater management plans and stormwater control ordinances. Provides the content requirements and procedures for the adoption and implementation of regional stormwater management plans and municipal stormwater management plans. Establishes design and performance standards for stormwater management measures and establishes safety standards for stormwater management basins. Establishes the design and performance standards for stormwater management measures for major development, which

Table 2-2: Action-Specific Applicable Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBCs)

Newark Bay Study Area, Newark Bay, New Jersey
Remedial Action Objectives & Preliminary Remedial Goals Technical Memorandum

Act/Regulation	Citation	ARAR or TBC	General Description
			includes any development that disturbs one (1) or more acre of land or increases existing impervious surface by ¼ acre or more.
NJ Soil Erosion and Sediment Control Act	N.J.S.A. 4 :24-39 et seq.	ARAR	Regulates construction that will potentially result in erosion of soils and sediment. Applicable to activities that disturb 5,000 square feet or more of land.
Noise Control	N.J.A.C. 7:29	ARAR	Sets forth regulations relating to the control and abatement of noise. Defines acceptable noise levels for industrial, commercial, public service, or community service facilities.
NJSWMA and New Jersey Solid and Hazardous Waste Rules	N.J.S.A. §13:1E-1, et seq.; N.J.A.C. 7:26, 7:26B and 7:26G	ARAR	Establishes requirements for generators, transporters, and facilities that manage solid waste and hazardous waste, and for thermal destruction facilities. Establishes standards and requirements for the management of solid waste (including regulated medical waste) – including registration, operation, maintenance, and closure of solid waste facilities and registration, operation, and maintenance of solid waste transport vehicles.
New Jersey Air Pollution Control Act	N.J.S.A. § 26:2C et seq., N.J.A.C. 7:27	ARAR	Specific to the protection and improvement of air quality. Regulates emissions that introduce contaminants into the ambient atmosphere for a variety of substances and from a variety of sources; controls and prohibits air pollution, particle emissions, and toxic VOC emissions.
NYSDEC 401 Water Quality Certification	Section 401 of the Clean Water Act	ARAR	Requires that NYSDEC assess whether the project will comply with State water quality standards. Issuance of a WQC is to support issuance of USACE concurrence. (Not included in LPR FFS.)
NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity	6 NYCRR Parts 750-758	ARAR	Requires preparation of a SWPPP for land disturbance of one or more acres and acquisition of general permit prior to construction. Requires approval for discharge of dewatering effluent directly to surface water. (Not included in LPR FFS.)
New York Air Pollution Control Law and New York State Air Quality Standards	NYS ECL Article 19, Title 3; 6 NYCRR Part 257	ARAR	Establishes that the emission of air contaminants to the outside atmosphere that jeopardize human, plant, or animal life, or are ruinous to property, or which unreasonably interfere with the comfortable enjoyment of life or property, is prohibited. (Not included in LPR FFS.)
NY Hazardous Waste Rules	NYS ECL, Article 27, Title 9; NYCRR Parts 371-373	ARAR	Establishes procedures for identifying solid wastes that are subject to regulation as hazardous wastes, including manifest system, treatment, storage, and disposal requirements. (Not included in LPR FFS.)

Note: The table provides the list of preliminary Federal and State action-specific ARARs and TBCs for the NBSA. The listed ARARs and TBCs, references, and descriptions have been pulled from the ARARs and TBCs outlined in the LPR FFS due to the contiguous relationship between the two waterbodies and various OUs of the of Site (see specifically Table 2-1a). Additional ARARs and TBCs have been added beyond the LPR FFS to due potential applicability for the NBSA (these are noted under the General Description).

Acronyms and Abbreviations:
ARAR = applicable or relevant and appropriate requirements

Table 2-2: Action-Specific Applicable Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBCs)

Newark Bay Study Area, Newark Bay, New Jersey
Remedial Action Objectives & Preliminary Remedial Goals Technical Memorandum

CAA = Clean Air Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CO = carbon monoxide
CWA = Clean Water Act
ECL = Environmental Conservation Law
LPR FFS = Focused Feasibility Study for OU2 in the Lower Passaic River
N = nitrogen
NBSA = Newark Bay Study Area
NJ = New Jersey
N.J.A.C. = New Jersey Administrative Code
NJDEP = New Jersey Department of Environmental Protection
NJPDES = New Jersey Pollutant Discharge Elimination System
N.J.S.A. = New Jersey Statutes Annotated
NJSWMA = New Jersey Solid Waste Management Act
NYSDEC = New York State Department of Environmental Conservation
OSR = Off-Site Rule
O_3 = Ozone
PCB = polychlorinated biphenyl
PM_{10}= Particulate matter equal to or less than 10 microns particle size
RCRA = Resource Conservation and Recovery Act
SO_2 = sulfur dioxide
SPDES = State Pollution Discharge Elimination System
SWPPP = Stormwater Pollution Prevention Plan
TBC = to be considered criteria
TCLP = Toxicity Characteristic Leaching Procedure
TSCA = Toxic Substances Control Act
USACE = U.S. Army Corps of Engineers
USEPA = U.S. Environmental Protection Agency
U.S.C. = United States Code
VOC = volatile organic compound
WQC = Water Quality Certificate

FIGURES

City: Citrix Div/Group: IM/DV Created By: K. SINSABAUGH Last Saved By: mestifanos
Newark Bay (B0009989.0061.00004)
Z:\GISProjects_ENV\GSH\GIS\Task\NBSA\FeasibilityStudy\mxd\Fig1-1_NewarkRegionalMap.mxd 12/18/2019 10:13:12 AM

NEW YORK
FOCUS AREA
NEW JERSEY

LEGEND:
NEWARK BAY STUDY AREA BOUNDARY

DUNDEE DAM
SADDLE RIVER
PASSAIC COUNTY
RIDGEFIELD PARK VILLAGE
BELLMANS CREEK
THIRD RIVER
BERGEN COUNTY
EAST RUTHERFORD BORO
BERRYS CREEK CANAL
BERRYS CREEK
CROMAKILL CREEK
KINGSLAND CREEK
SECOND RIVER
SAWMILL CREEK
FRANKS CREEK
80 AND 120 LISTER AVENUE (OU1)
PASSAIC RIVER
ESSEX COUNTY
LAWYERS CREEK
HARRISON CREEK
PLUM CREEK
PIERSONS CREEK
HACKENSACK RIVER
HUDSON COUNTY
PORT NEWARK CHANNEL
PORT NEWARK
NEWARK LIBERTY INTERNATIONAL AIRPORT
ELIZABETH CHANNEL
NEWARK BAY
PERIPHERAL DITCH
PORT ELIZABETH
SOUTH ELIZABETH CHANNEL
UPPER NEW YORK BAY
ELIZABETH RIVER
PLATTY KILL CREEK
MORSES CREEK
SHOOTERS ISLAND
MARINERS MARSH
KILL VAN KULL
ARLINGTON MARSH
OLD PLACE CREEK
UNION COUNTY
PILES CREEK
PRALLS ISLAND
RAHWAY RIVER
STATEN ISLAND
FRESH KILLS
ARTHUR KILL
MIDDLESEX COUNTY
RARITAN RIVER
RARITAN BAY

LEGEND:
RIVER/BAY MILE
80 AND 120 LISTER AVENUE (OU1)
LOWER 8.3 MILES OF THE PASSAIC RIVER (OU2)
LOWER 17 MILES OF THE PASSAIC RIVER (OU4)
NEWARK BAY STUDY AREA BOUNDARY (OU3)

NOTES:

1. BASEMAP INFORMATION FROM NOAA CHARTS 12331, 12333, AND 12337, DATED MAY 4, 1995.
2. THE NEWARK BAY STUDY AREA BOUNDARY PRESENTED WAS USEPA-APPROVED AND UTILIZED IN THE PHASE I, II, AND III SEDIMENT INVESTIGATIONS, BUT MAY BE CHANGED BY USEPA FOR FUTURE INVESTIGATIONS UNDER THE RI/FS.

0 2 4 Miles
GRAPHIC SCALE

DIAMOND ALKALI SUPERFUND SITE
NEWARK BAY STUDY AREA
FEASIBILITY STUDY

NEWARK BAY REGIONAL MAP

OXY Glenn Springs Holdings, Inc.
A subsidiary of Occidental Petroleum Corporation

FIGURE 1-1

City: Citrix Div/Group: IM/DV Created By: K. Sinsabaugh Last Saved By: mestifanos
GSH (B0009989.0061.00013)
Z:\GISProjects_ENV\GSH\GIS\Task\NBSA\FeasibilityStudy\mxd\Fig3-1_SedimentToxicityResults.mxd 12/18/2019 10:10:11 AM

LEGEND:

- 10-DAY SURVIVAL FOR *LEPTOCHEIRUS PLUMULOSUS*
- 28-DAY SURVIVAL FOR *LEPTOCHEIRUS PLUMULOSUS*
- SURVIVAL STATISTICALLY DIFFERENT THAN CONTROLS
- SURVIVAL NOT STATISTICALLY DIFFERENT THAN CONTROLS
- NAVIGATION CHANNEL
- SHORELINE
- UNDERGROUND TRIBUTARY
- PHASE I/PHASE II SI STUDY AREA BOUNDARY

ASSESSMENT ZONES

- NORTH
- SOUTHEAST
- SOUTHWEST
- REGULARLY DREDGED DEEP WATER CHANNELS

PIERSONS CREEK
PORT NEWARK CHANNEL
ELIZABETH CHANNEL
NEWARK LIBERTY INTERNATIONAL AIRPORT
NEWARK BAY CDF (CELL 1S)
PERIPHERAL DITCH
SOUTH ELIZABETH CHANNEL
NEWARK BAY
KILL VAN KULL
SHOOTERS ISLAND

164 140 163 165 162 136 161 137 138 160 159 158 139 157 141 142 156 143 144 155 145 154 153 152 151 146 150 149 148 147

NOTES:

1. HORIZONTAL DATUM: NEW JERSEY STATE PLANE COORDINATE SYSTEM, NAD83.
2. SHORELINE IS DIGITIZED FROM AERIAL PHOTO DATED JULY 2002 (INTRASEARCH, ENGLEWOOD, CO).

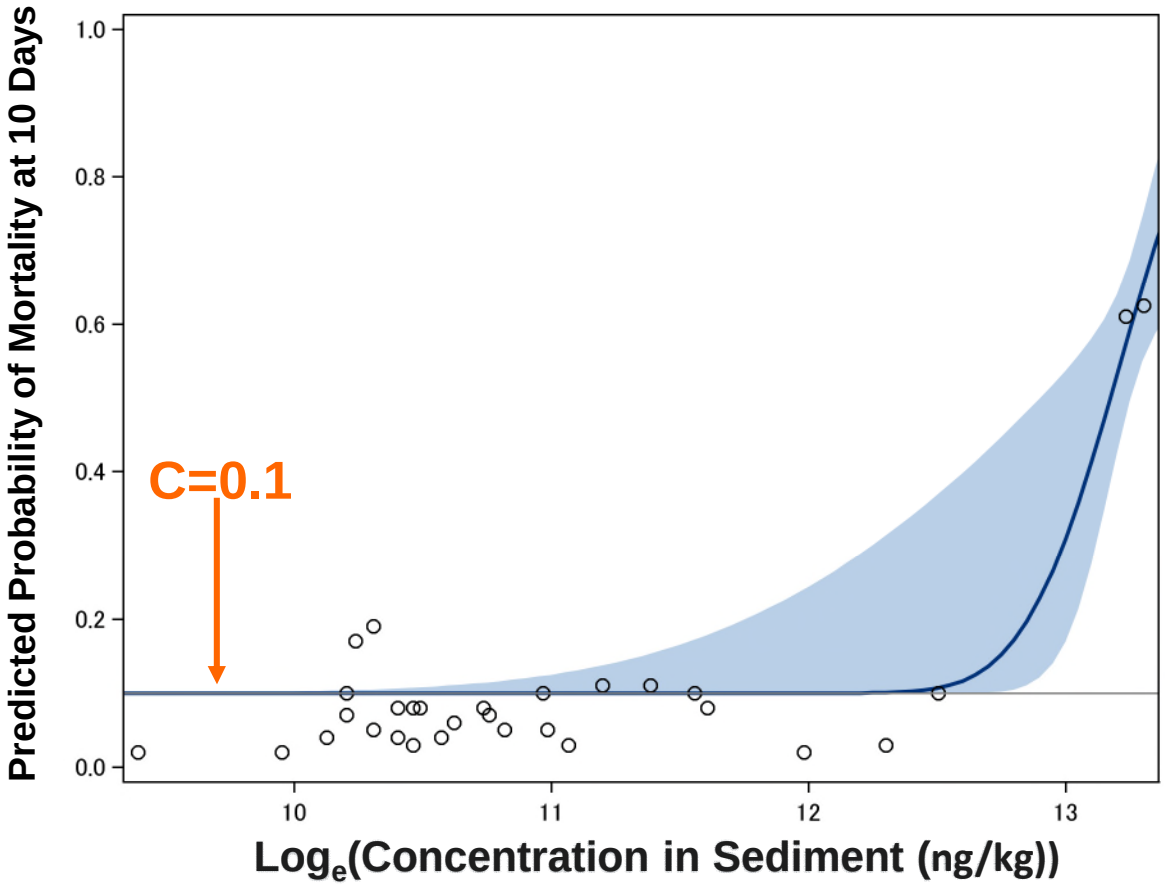
0 2,500 5,000 Feet
GRAPHIC SCALE

DIAMOND ALKALI SUPERFUND SITE
NEWARK BAY STUDY AREA
FEASIBILITY STUDY

SEDIMENT TOXICTY RESULTS

Glenn Springs Holdings, Inc.
A subsidiary of Occidental Petroleum Corporation

FIGURE
3-1



Fitted Probit Model:

$\pi = C+(1-C)F(\alpha + \beta x)$

π = Probability of mortality at 10 days
C = 0.1 (i.e. control mortality)
F = Cumulative Standard Normal Distribution Function
α = -44.78
β = 3.388
x = $\log_e$(Concentration)

Notes;
Model is based on 10-day *L. plumulosus* mortality observed in the NBSA Sediment Quality Triad Investigation.

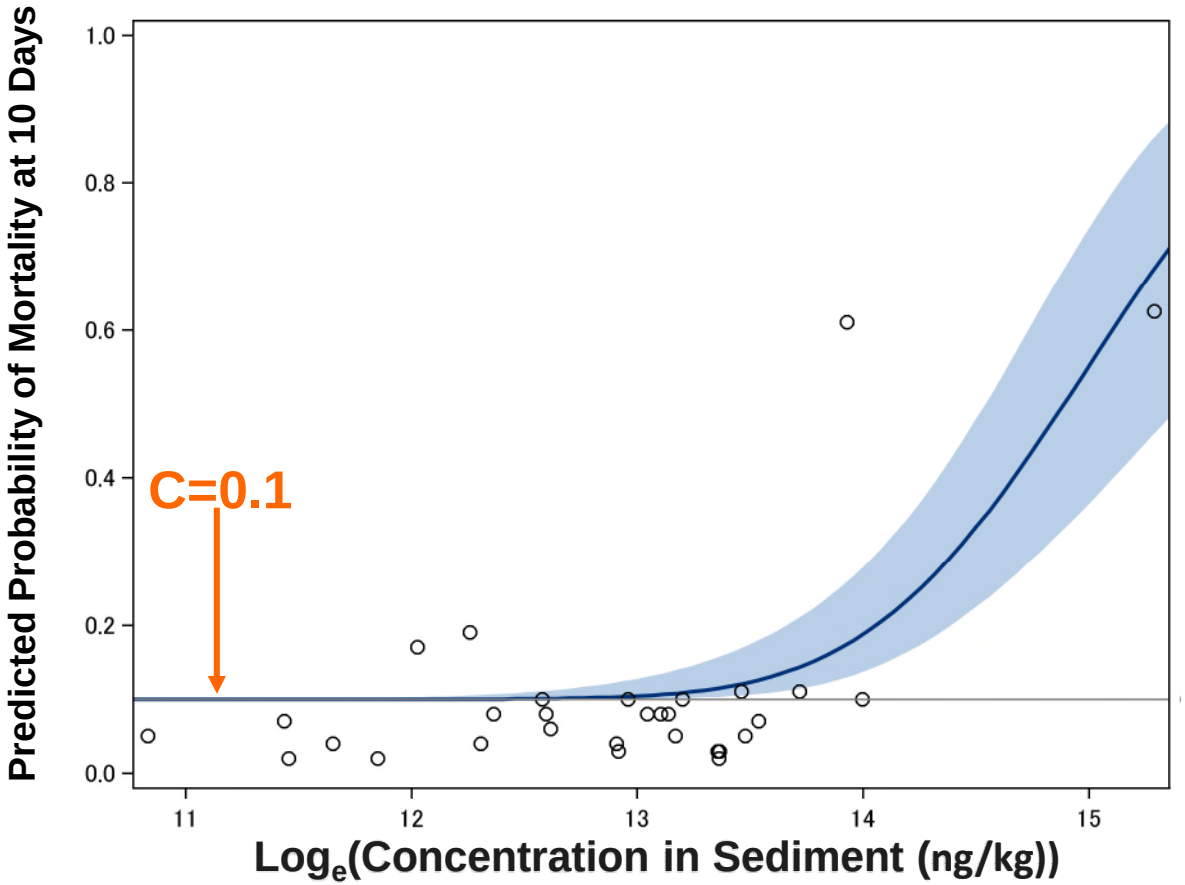
ng/kg = nanograms per kilogram

DIAMOND ALKALI SUPERFUND SITE
NEWARK BAY STUDY AREA
FEASIBILITY STUDY

Dose Response Model for Total (2,4' and 4,4') DDx

Glenn Springs Holdings, Inc.
A subsidiary of Occidental Petroleum Corporation

FIGURE
3-2a



Fitted Probit Model:

$\pi = C+(1-C)F(\alpha + \beta x)$

π = Probability of mortality at 10 days
C = 0.1 (i.e. control mortality)
F = Cumulative Standard Normal Distribution Function
α = -19.51
β = 1.301
$x = \log_e$(Concentration)

Notes;
Model is based on 10-day *L. plumulosus* mortality observed in the NBSA Sediment Quality Triad Investigation.

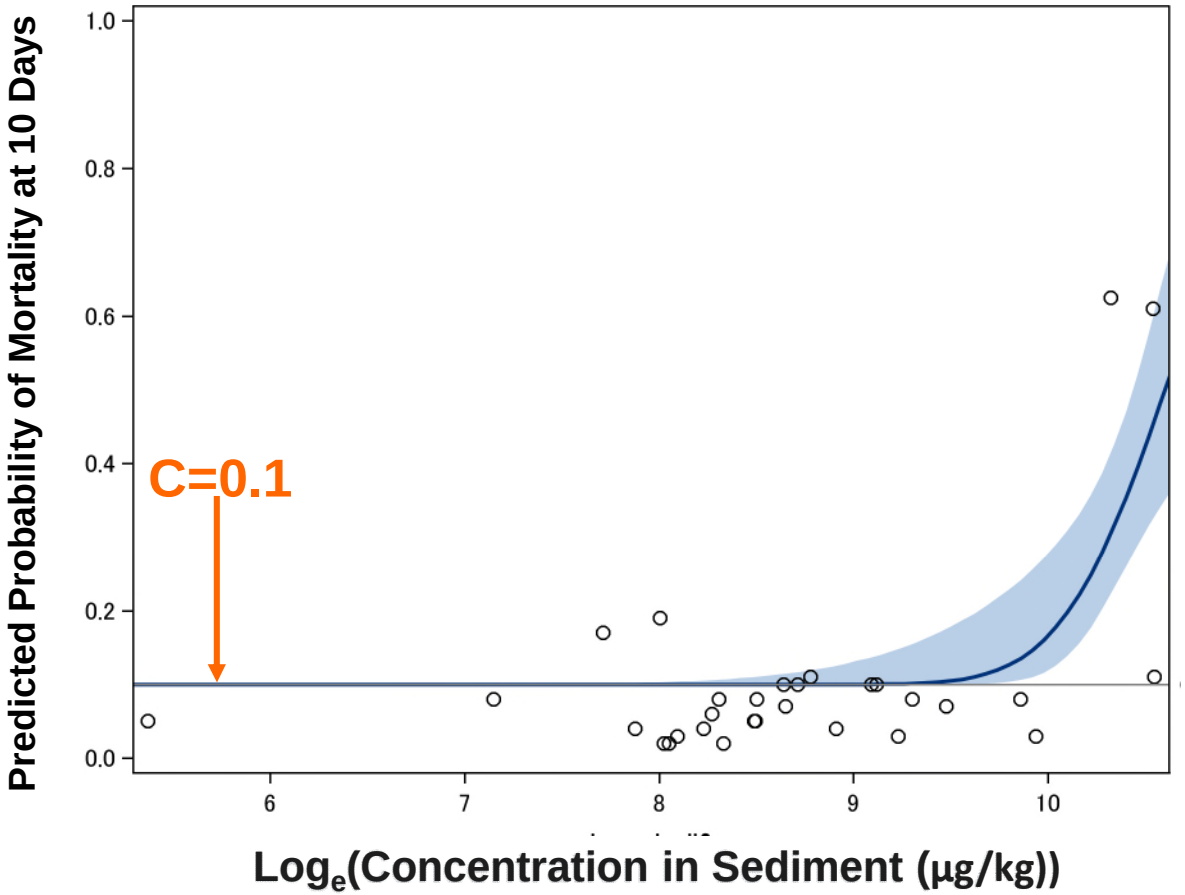
ng/kg = nanograms per kilogram

DIAMOND ALKALI SUPERFUND SITE
NEWARK BAY STUDY AREA
FEASIBILITY STUDY

Dose Response Model for Total PCBs

OXY Glenn Springs Holdings, Inc.
A subsidiary of Occidental Petroleum Corporation

FIGURE
3-2b



Fitted Probit Model:

$\pi = C+(1-C)F(\alpha + \beta x)$

π = Probability of mortality at 10 days
C = 0.1 (i.e. control mortality)
F = Cumulative Standard Normal Distribution Function
α = -23.25
β = 2.180
x = $\log_e$(Concentration)

Notes;
Model is based on 10-day *L. plumulosus* mortality observed in the NBSA Sediment Quality Triad Investigation.

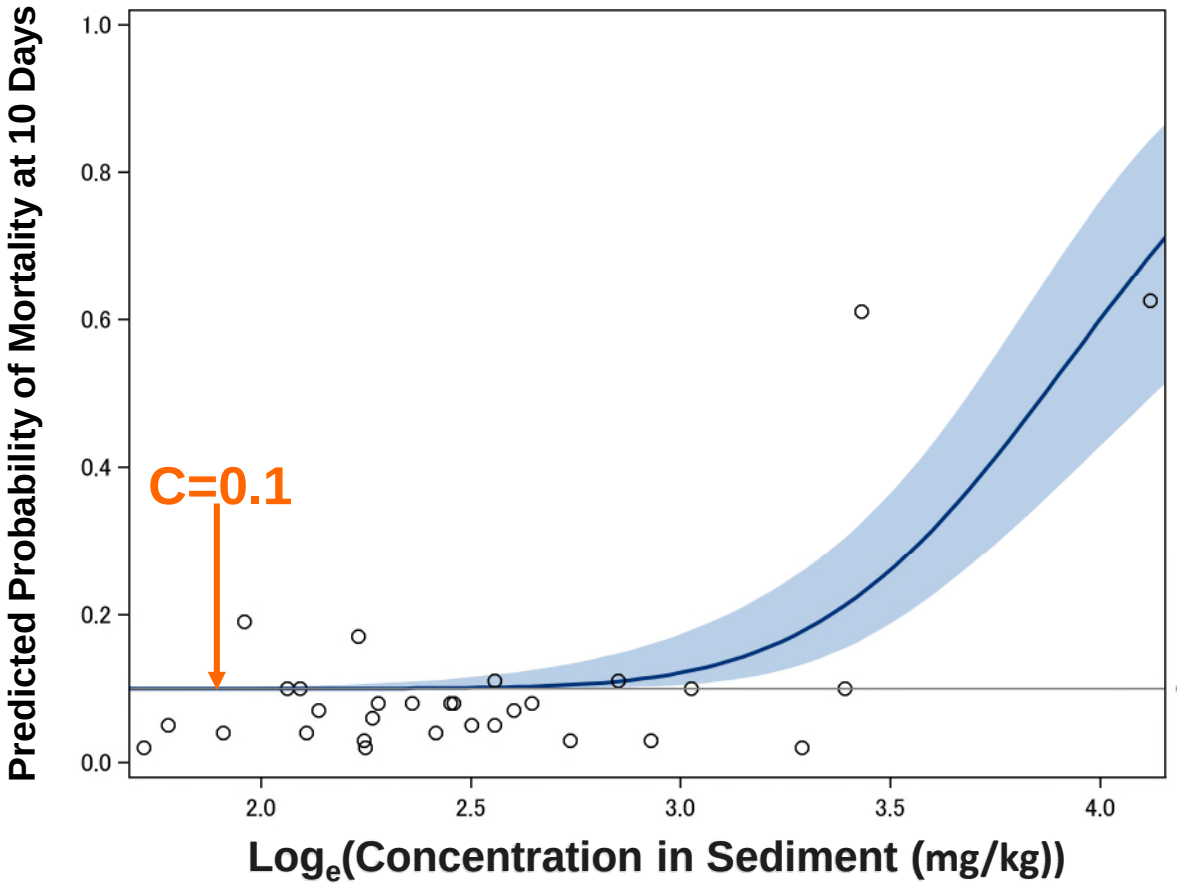
µg/kg = micrograms per kilogram

DIAMOND ALKALI SUPERFUND SITE
NEWARK BAY STUDY AREA
FEASIBILITY STUDY

Dose Response Model for Total Alkylated PAHs

Glenn Springs Holdings, Inc.
A subsidiary of Occidental Petroleum Corporation

FIGURE
3-2c



Fitted Probit Model:

$\pi = C+(1-C)F(\alpha + \beta x)$

π = Probability of mortality at 10 days
C = 0.1 (i.e. control mortality)
F = Cumulative Standard Normal Distribution Function
α = -8.351
β = 2.123
$x = \log_e$(Concentration)

Notes;
Model is based on 10-day *L. plumulosus* mortality observed in the NBSA Sediment Quality Triad Investigation.

mg/kg = milligrams per kilogram

DIAMOND ALKALI SUPERFUND SITE
NEWARK BAY STUDY AREA
FEASIBILITY STUDY

Dose Response Model for Arsenic

Glenn Springs Holdings, Inc.
A subsidiary of Occidental Petroleum Corporation

FIGURE
3-2d